C-2351

Claims

1. A hydrocarbon fuel autothermal reformer assembly comprising:
a) a catalyst bed, said catalyst bed including an inlet end;
b) an air/fuel/steam mixing station adjacent to said inlet end of said catalyst bed, said mixing station including an inlet chamber, a manifold interposed between said inlet chamber and said catalyst bed inlet end, and a plurality of cylindrical transfer tubes extending through said manifold from said inlet chamber to said inlet end of said catalyst bed;
c) a plurality of gas entry passages in side walls of each of said transfer tubes, each of said gas passages having an axis which is perpendicular to an axis of said transfer tubes, each of said gas entry passages being spaced apart from said catalyst bed inlet end a distance which is at least two times the diameter of said cylindrical transfer tubes;
d) a first gas inlet passage opening into said inlet chamber; and
e) a second gas inlet passage opening into said manifold.

2. The autothermal reformer assembly of Claim 1 further comprising a vaporizer station connected with one of said first or second gas inlet passages, said vaporizer being operable to vaporize a fuel/steam mixture prior to entry of the mixture into said mixing station.

3. A method for mixing a fuel/steam gas with an oxidant gas to form an essentially homogeneous fuel/steam/oxidant mixture suitable for use in an autothermal fuel gas reformer catalyst bed, said method comprising the steps of:
a) providing an autothermal reformer catalyst bed having an inlet end;
b) providing an air/fuel/steam mixing station adjacent to said inlet end of said catalyst bed, said mixing station including an inlet chamber, a manifold interposed between said inlet chamber and said catalyst bed inlet end;
c) providing a plurality of cylindrical transfer tubes extending through said manifold from said inlet chamber to said inlet end of said catalyst bed each of said cylindrical transfer tubes having a plurality of gas entry passages in side walls of each of said

transfer tubes, each of said gas passages having an axis which is perpendicular to an axis of said transfer tubes, each of said gas entry passages being spaced apart from said catalyst bed inlet end a distance which is at least two times the diameter of said cylindrical transfer tubes;

d) providing a first gas inlet passage opening into said inlet chamber;

e) providing a second gas inlet passage opening into said manifold;

f) Introducing a vaporized fuel/steam mixture into one of said inlet chamber or said manifold;

g) introducing an oxidant gas into the other of said inlet chamber or said manifold;

h) causing one of said fuel/steam mixture or said oxidant gas stream to flow axially through said transfer tubes toward said inlet end of said catalyst bed;

i) causing the other of said fuel/steam mixture or said oxidant to flow from said manifold radially into said transfer tubes through said gas entry passages; and

j) maintaining a pressure differential between the interior of said transfer tubes and said manifold which will result in the radially flowing stream entering said transfer tubes to be entrained and deflected into the axially flowing stream in the transfer tubes before the radially flowing stream penetrates the interior of the transfer tubes a distance which is about one-half of the radius of the interior of the transfer tubes.

4. The method of Claim 3 wherein said pressure differential between the gas stream in said transfer tubes and the gas stream in said manifold is only a few percentage points.

5. The method of Claim 3 wherein the fuel is gasoline.

6. The method of Claim 3 wherein the fuel is diesel fuel.

7. The method of Claim 3 wherein the fuel is methanol.

8. A method for mixing a fuel/steam gas with an oxidant gas to form an essentially homogeneous fuel/steam/oxidant mixture suitable for use in an autothermal fuel gas reformer catalyst bed, said mixing method taking place in a fuel processing apparatus which includes an autothermal reformer catalyst bed having an inlet end, an

oxidant/fuel/steam mixing station adjacent to said inlet end of said catalyst bed, said mixing station including an inlet chamber, a manifold interposed between said inlet chamber and said catalyst bed inlet end, and a plurality of cylindrical transfer tubes extending through said manifold from said inlet chamber to said inlet end of said catalyst bed each of said cylindrical transfer tubes having a plurality of gas entry passages in side walls of each of said transfer tubes, each of said gas passages having an axis which is perpendicular to an axis of said transfer tubes, each of said gas entry passages being spaced apart from said catalyst bed inlet end a distance which is at least two times the diameter of said cylindrical transfer tubes, said method comprising the steps of:

a) providing a first gas inlet passage opening into said inlet chamber;

b) providing a second gas inlet passage opening into said manifold;

c) Introducing a vaporized fuel/steam mixture into one of said inlet chamber or said manifold;

d) introducing an oxidant gas into the other of said inlet chamber or said manifold;

e) causing one of said fuel/steam mixture or said oxidant gas stream to flow axially through said transfer tubes toward said inlet end of said catalyst bed;

f) causing the other of said fuel/steam mixture or said oxidant to flow from said manifold radially into said transfer tubes through said gas entry passages; and

g) maintaining a pressure differential between the interior of said transfer tubes and said manifold which will result in the radially flowing stream entering said transfer tubes to be entrained and deflected into the axially flowing stream in the transfer tubes when the radially flowing stream penetrates the interior of the transfer tubes a distance which is about one-half the radius of the interior of the transfer tubes.

9. The method of Claim 8 wherein the fuel is gasoline.

10. The method of Claim 8 wherein the fuel is diesel fuel.

11. The method of Claim 8 wherein the fuel is methanol.

12. The method of Claim 8 wherein said fuel/steam mixture is passed axially through said transfer tubes and said oxidant enters said transfer tubes from said manifold.

13. A method for mixing an oxidant/steam gas with a vaporized fuel to form an essentially homogeneous fuel/steam/oxidant mixture suitable for use in an autothermal fuel gas reformer catalyst bed, said mixing method taking place in a fuel processing apparatus which includes an autothermal reformer catalyst bed having an inlet end, an oxidant/fuel/steam mixing station adjacent to said inlet end of said catalyst bed, said mixing station including an inlet chamber, a manifold interposed between said inlet chamber and said catalyst bed inlet end, and a plurality of cylindrical transfer tubes extending through said manifold from said inlet chamber to said inlet end of said catalyst bed each of said cylindrical transfer tubes having a plurality of gas entry passages in side walls of each of said transfer tubes, each of said gas passages having an axis which is perpendicular to an axis of said transfer tubes, each of said gas entry passages being spaced apart from said catalyst bed inlet end a distance which is at least two times the diameter of said cylindrical transfer tubes, said method comprising the steps of:

a) providing a first gas inlet passage opening into said inlet chamber;

b) providing a second gas inlet passage opening into said manifold;

c) introducing a vaporized fuel stream into one of said inlet chamber or said manifold;

d) introducing an oxidant/steam mixture into the other of said inlet chamber or said manifold;

e) causing one of said fuel stream or said oxidant/steam mixture to flow axially through said transfer tubes toward said inlet end of said catalyst bed;

f) causing the other of said vaporized fuel stream or said oxidant/steam mixture to flow from said manifold radially into said transfer tubes through said gas entry passages; and

g) maintaining a pressure differential between the interior of said transfer tubes and said manifold which will result in the radially flowing stream entering said transfer tubes to be entrained and deflected into the axially flowing stream in the transfer tubes when the radially flowing stream penetrates the interior of the transfer tubes a distance which is about one-half the radius of the interior of the transfer tubes.

14. The method of Claim 13 wherein the fuel is gasoline.

15. The method of Claim 13 wherein the fuel is diesel fuel.

16. The method of Claim 13 wherein the fuel is methanol.

17. The method of Claim 13 wherein said fuel stream is passed axially through said transfer tubes and said oxidant/steam mixture enters said transfer tubes from said manifold.